

SUNY College of Environmental Science and Forestry

Digital Commons @ ESF

Honors Theses

5-2013

Identifying Communities of Concern: A Tract Level Analysis of the Food Landscape in Syracuse, New York

Michelle Meyer

Follow this and additional works at: <https://digitalcommons.esf.edu/honors>



Part of the [Nutrition Commons](#), and the [Social Welfare Commons](#)

Recommended Citation

Meyer, Michelle, "Identifying Communities of Concern: A Tract Level Analysis of the Food Landscape in Syracuse, New York" (2013). *Honors Theses*. 9.

<https://digitalcommons.esf.edu/honors/9>

This Thesis is brought to you for free and open access by Digital Commons @ ESF. It has been accepted for inclusion in Honors Theses by an authorized administrator of Digital Commons @ ESF. For more information, please contact digitalcommons@esf.edu, cjkoons@esf.edu.

Identifying Communities of Concern:
A Tract Level Analysis of the Food Landscape in Syracuse, New York

by

Michelle Meyer
Candidate for Bachelor of Science
Department of Environmental Studies
With Honors

May 2013

APPROVED

Thesis Project Advisor: _____
Myrna H. Hall

Second Reader: _____
Dr. Lee Herrington

Honors Director: _____
William M. Shields, Ph.D.

Date: _____

Abstract

Food security is defined by the United States Department of Agriculture (USDA) as access by all members of the household to enough food to live an active, healthy life at all times [1]. Food security has also been identified as an important public health concern, subsequently amplifying interest in identifying communities with limited accessibility to quality food retailers. The primary focus of this analysis was to identify communities of heightened food security concern in Syracuse, NY based on three measures of physical accessibility: proximity to the nearest grocer, diversity of grocers within 1km, and variety of grocers based on the average distance to the three nearest grocers; and social deprivation. Further, I hypothesized areas with the greatest social deprivation would also exhibit reduced physical accessibility to quality food retailers. Spatial analysis was conducted using Environmental Systems Research Inc. (ESRI) ArcMap 10 software.

Twenty-five percent of census tracts throughout Syracuse exhibit high or very high food security concern. These communities are clustered predominantly in the southern portion of the city, although additional areas of concern can be found in the northwest and eastern parts of Syracuse. Although the majority of these communities exhibit high levels of social deprivation, some also illustrate the lowest levels of deprivation. As a result, the communities of food security concern identified through this analysis are not representative of traditional “food deserts,” but rather a combination of “food deserts” and “food hinterlands.” There was no correlation between social deprivation and physical accessibility to quality food retailers observed within this analysis.

Table of Contents

I. List of Figures	4
II. List of Graphs and Tables	4
III. Glossary of Terms	5
IV. Acknowledgements	6
V. Introduction	7
VI. Methods	12
VII. Results	20
VIII. Discussion	32
IX. Conclusion	35
X. References	38
XI. Appendices	40

I. List of Figures

Figure 1: Spatial Distribution of High Quality Grocers and Physical Accessibility at the Census Tract Level – pg. 23

Figure 2: Spatial Distribution of High and Intermediate Quality Grocers and Physical Accessibility at the Census Tract Level – pg. 24

Figure 3: Spatial Distribution of High Quality Grocers and Physical Accessibility at the Neighborhood Level – pg. 26

Figure 4: Spatial Distribution of High and Intermediate Quality Grocers and Physical Accessibility at the Neighborhood Level – pg. 27

Figure 5: Socioeconomic and Demographic Risk at the Census Tract Level – pg. 28

Figure 6: Communities of Concern: Food Insecurity Risk at the Census Tract Level – pg. 29

Figure 7: Food Supplier Density at the Census Tract Level – pg. 30

Figure 8: Food Supplier Density at the Neighborhood Level – pg. 31

II. List of Graphs and Tables

Graph 1: Physical Accessibility Food Insecurity Risk vs. Social Deprivation – pg. 21

Graph 2: Physical Accessibility to Closest High Quality Grocer vs. Social Deprivation – pg. 21

Table 1: Descriptive Statistics of Social Deprivation Index Variables in Census Tracts in Syracuse, NY – pg. 17

III. Glossary of Terms

Food Security – access by all people at all times to enough food for an active, healthy life [1]

Food Insecurity – limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways [1]

Food Desert – low income areas where a significant number or share of residents is far from a supermarket [1]

Food Hinterland – areas that lack adequate physical access to grocers but are not considered food deserts because the majority of residents exhibit adequate means of economic accessibility [2]

Social Deprivation – the compilation of multiple socio-economic factors such as poverty status, unemployment, lack of vehicle access, family dynamics, minority status, and educational attainment, which together contribute to social exclusion and inhibit adequate accessibility to goods and services

IV. Acknowledgements

The research reported in this paper was conducted in partnership with the State University of New York College of Environmental Science and Forestry's Honors Program. My deepest gratitude extends to all faculty and staff members who helped guide my research efforts, and to the honors program for this unique opportunity to fuse my academic endeavors with hands-on experience. Specifically, I would like to thank my thesis advisor, Myrna Hall, for her unwavering support, direction, and encouragement; and Dr. Lee Herrington for his assistance in editing and revision. I would also like to extend my gratitude to the Atlantic States Legal Foundation and the Syracuse Hunger Project for their contribution of unique, local knowledge and community-based ArcGIS data.

V. Introduction

Food security, or the access to enough food to live an active, healthy life at all times, has been identified as an important public health concern, influencing not only personal health outcomes but also the larger physical and social health of entire communities [1]. Conversely, food insecurity can be understood as, “limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways” [1]. Food security is influenced by food availability, or an adequate food supply; food stability, or the stability of the food supply even during periods of drought; and food access, or physical and economic accessibility to food [3]. The food supply in the United States is both abundant and stable; therefore, food insecurity can largely be understood as a problem of individual food accessibility, influenced by physical and societal factors [3].

In 2000, 12 million children and 31 million Americans were reported as food insecure in 1999, with poverty being the primary cause of insecurity [4]. In 2001, 11.3% of the population (roughly 31 million people) lived below the poverty line, making less than \$17,960 annually per family of four, and spending one-third or more of their income on food [4]. In 2011, the percentage of households considered food insecure at some point during the year increased to 14.9%, with the archetypal food-secure household spending 24% more on food than food-insecure households of the same size and structure [1]. Food insecurity can dramatically hinder quality of life, and insufficient nutrition is correlated with school and work absences, fatigue, problems with concentration, and increased incidence of infectious diseases [4]. Insufficient nutrition is also a risk factor for a number of chronic diseases including diabetes, hypertension, and heart failure [4].

In addition, children exposed to chronic hunger often experience greater levels of depression, anxiety and other behavioral problems [4].

As the accuracy of geographic information systems advance and more intricate mapping software is developed, the ability to understand the relationship between our physical environment and chronic societal problems such food insecurity and hunger improves. According to Don Mitchell, the Chair of the Department of Geography at Syracuse University's Maxwell School of Citizenship and Public Affairs:

“... hunger has a *geography*. The history of hunger – and the struggle to ameliorate it – has created a vastly uneven landscape where deep food insecurity can exist cheek by jowl with abundant wealth and comfort. The sociology of hunger helps define a map upon which the threat of hunger, malnutrition and perhaps even starvation clumps together in some neighborhoods and not others, stalks *these* children, but not *those*. The politics of hunger creates a complex topography of access to resources, the right to benefits, and the provision of emergency aid by churches, government agencies, and individual citizens.... GIS allows us to *see* hunger in a new way [5].”

Through utilizing geographic information technology, it becomes possible to map the Syracuse food landscape with a particular focus on the physical accessibility of high and intermediate quality grocers in conjunction with other socioeconomic and demographic factors, and to explore the relationship between social deprivation, or the compilation of multiple socio-economic factors which together contribute to social exclusion, and physical accessibility, or geographic proximity, to quality food retailers.

Previous studies on food accessibility have suggested the availability of supermarkets and other stores offering a diverse array of reasonably priced healthful foods varies by income and ethnicity within the United States, often exhibited by greater supermarket access in higher income neighborhoods with a higher proportion of white residents, and greater access to smaller grocers within poorer neighborhoods with high minority populations [6, 7, 8, 9]. Studies have also indicated low-income households often face higher food prices as a result of reduced access to suburban chain-supermarkets where there is a greater range of brands and package sizes and lower prices [7, 8]. However, a survey of household food expenditures conducted by Kaufman et al. suggests despite higher pricing in local markets, low-income households generally spend less on the foods they buy on a per unit basis, most likely due to selecting lower quality foods or foods that are more economically viable [8]. Low-income, minority communities also frequently demonstrate high rates of food insecurity and increased vulnerability to poor health outcomes as a result of fewer fruit and vegetable purchases than higher-income households [4, 6, 10]. These differences in accessibility are in part the result of the relative purchasing power of various geographic regions, economies of scale available to large suburban-based retailers, and other market dynamics [11, 12, 13, 14]. Despite these influences, it remains important to identify areas lacking adequate access to healthful foods to promote equitable health opportunities for all residents. More importantly, when access to healthful food is limited, more time and/or money must be expended to eat a nutritious diet, and economically stressed households may be particularly inclined to substitute unhealthy food for healthy food, leading to an increased risk of obesity [6]. Numerous studies have also linked beneficial local food environments

and increased supermarket access to positive health outcomes such as improved diet, greater fruit and vegetable intake, and lower adolescent body mass index [15, 16, 17].

When contemplating the Syracuse food landscape, it is important to note that Syracuse exhibits characteristics of a typical rust belt city, once a bustling hub of commercial activity and manufacturing, left to fallow in the wake of industrial decline and the subsequent restructuring of the local economy [18]. Syracuse was the twelfth most populous city in the country during the 1850s, but is now home to a plethora of vacant spaces as the result of suburban flight and failed attempts of urban renewal. More persistent problems such as underemployment; unemployment; low wages; and rising healthcare, housing, and childcare costs also plague the city [Jonnell Robinson, Syracuse University Community Geographer, personal communication]. Previous case-studies of the region have indicated the susceptibility of Syracuse children to childhood lead poisoning, and greater energy use disparities among the urban poor of Syracuse, who expend a greater portion of their household energy budget on necessities such as food, heating and cooling [19, 20]. A study published in 2001 by Joe Grengs also found 12% of Syracuse households lack reasonable access to supermarkets, a statistic encompassing over 7,500 households in total [21]. In addition, Grengs found limited supermarket accessibility to be associated with low-income neighborhoods and neighborhoods with a disproportionately high African American population, and lack of transportation infrastructure [21]. These documented disparities highlight present-day food security concerns, and make Syracuse an excellent location to investigate and better understand the geography of hunger.

Objective: The primary objective of this analysis is therefore to identify communities of food security concern based on three specific measures of accessibility: distance to the nearest grocer, diversity of grocers within 1km, and variety of grocers based on the average distance to the three nearest grocers; and social deprivation.

Hypothesis: areas with the greatest social deprivation will also exhibit reduced physical accessibility to quality food retailers.

The three physical accessibility measures that will be utilized within this analysis are derived from the gravity model, the most commonly used measure of accessibility, consisting of the mean distance to all services, the distance to the closest service, and the mean distance to all services within a defined radius [22]. In a 2007 study on food deserts within Montréal, the gravity model was adapted to evaluate accessibility to supermarkets on the census tract level, identifying three primary measures of accessibility as: Measure 1 – the distance to the closest supermarket (proximity), Measure 2 – the number of supermarkets within a walkable distance of less than 1km (diversity), and Measure 3 – the mean distance to three different supermarkets belonging to different companies (variety) [22].

In addition, this analysis expands upon social deprivation characteristics identified by Grengs (low-income and a disproportionately high African American population) to include the percentage of families below poverty level, the percentage of unemployed individuals, the percentage of households without access to a vehicle, the percentage of female-headed households with no husband present and children under the age of 18, the

percentage of minority individuals, and the percentage of adults over the age of 25 with less than a high school education.

The inclusion of multiple physical accessibility measures in addition to social deprivation will provide insight into which areas of Syracuse exhibit heightened food security concern as a result of both physical accessibility and social deprivation collectively, diverging from the traditional identification of food deserts to include a combination of food deserts and food hinterlands. The concept of a food hinterland was introduced in a 2012 study by Leete et al. and refers to, “neighborhoods that lack adequate access to supermarkets, but are not considered food deserts because they do not have a concentrated socioeconomic vulnerability” [2, 207]. Leete et al. argue that food access for low-income households in such areas remain largely unexamined and highlight the lack of consideration of these areas in policy and planning discussions [2]. Spatial overlay of physical accessibility and social deprivation may provide a more comprehensive understanding of overall food security, and could prove more helpful in identifying areas of concern particularly for individuals within higher-income neighborhoods who suffer from additional barriers to access not characteristic to their surrounding area, such as old age or disability.

VI. Methods

Study Area:

The study area consists of 56 census tracts that are completely contained within the city of Syracuse, New York, an area encompassing roughly 66 square kilometers. Syracuse is located in the center of New York State and serves as a beneficial study area

given its emblematic characterization as a rust-belt city and the resulting socio-economic consequences of its economic collapse. Classified as an urban center, Syracuse is currently home to roughly 145,151 residents, 66.4% of which are between the ages of 18 and 65. The Syracuse population reached its height in the 1980's, consisting of more than 250,000 residents, and has exhibited a 42% population decrease from its peak to present day. The city is also reasonably diverse, its composition 56% White, 29.5% Black, 5.5% Asian, 1.1% American Indian or Alaskan Native, 5.1% of two or more races, and 8.3% of Hispanic or Latino origin [23]. On average, 21.7% of families within Syracuse resided below the poverty level in 2000, with a mean unemployment rate of 5.5% [24]. In addition, 26.6% of households had no access to a vehicle, and 23.8% of adults age 25 or older had less than a high school education as of 2000 [25, 26]. Roughly 13% of family households within Syracuse also consisted of a female householder with children under the age of 18 and no husband present in the year 2000 [26]. The removal of some of these socio-economic indicators such as household and family structure, income, employment status, vehicle access, and educational attainment from the 2010 census limits present-day estimations of such specific community characteristics, although it has been suggested the socio-economic profile of the Syracuse area has remained relatively stable since the 2000 data were collected [Jonnell Robinson, Syracuse University Community Geographer, personal communication].

Grocer Data:

I identified supermarket, grocery and convenience stores throughout the city using North American Industry Classification System (NAICS) data collected from *SimplyMap*,

a web-based mapping application developed by Geographic Research, Inc (Appendix 1). The NAICS codes designating food sellers were “445110 Supermarkets and Other Grocery (except Convenience) Stores” (n=106) and “445120 Convenience Stores” (n=25), both of which reside within the larger “4451 Grocery Stores” classification. I identified additional grocery stores not included within *SimplyMap* data (n=15) using keywords ‘grocery’ and ‘market’ in *Google Earth*, and through identifying the locations of local grocery chains “Aldis,” “Price Chopper,” “PriceRite,” “Tops Friendly Markets,” and “Wegmans” in *Google Earth* (Appendix 1). I then attempted to visit each site to determine general food availability and variety within each store. Of the 146 grocers identified, I was able to collect data for 101. Grocers not included in the data collection (n=45) were either closed or not found.

The survey instrument (Appendix 2) assessed through observation the availability and variety of general food categories at each of the identified grocer locations, and was created using foods and food groups present within the USDA’s Community Food Security Assessment Toolkit [27]. A composite score for each site was calculated through adding and subtracting positive and negative indicators (Appendix 2). Positive indicators included the acceptance of electronic balance transfer cards (EBT), and the availability and variety of beans or legumes, nuts, fresh fruit and vegetables, canned fruit and vegetables, frozen fruit and vegetables, breads, cereal, pasta, rice, flour, milk, dairy products, eggs, fresh and frozen meat products, fresh and frozen poultry products, and fresh and frozen fisheries products (Appendix 2). Negative indicators included the sale of alcohol or tobacco, and the availability and variety of sugar, chips, candy, and soda or other sugary drinks (Appendix 2). These general food categories were identified as either

available or not available, and the variety of options within each category was noted on a scale of 1, 3 or 5 (Appendix 2). A variety of one indicated the availability of one or two items, a variety of three indicated the availability of three or four items, and a variety of five indicated the availability of five or more items (Appendix 2). The quality of fresh fruits and vegetables was also classified as either satisfactory or poor (Appendix 2). The composite score was used to identify high quality (score 65-90, n=20), intermediate quality (score 33-65, n=38), and poor quality (score < 33, n=43) grocers based on a three natural breaks classification. High quality grocers tended to consist of chain supermarkets, exhibited by the availability of nearly all food categories, and subsequent variety of five or greater within each category. Intermediate quality grocers typically exhibited availability of most processed food categories and a range in variety; including positive indicators such as canned and frozen fruits and vegetables, beans, grains, fresh or frozen animal products, eggs, milk and dairy products; and negative indicators such as chips, candy, sugar, and soda or other sugary drinks. Poor quality grocers typically consisted of corner stores with very limited availability and variety of positive food indicators, but a high availability and variety of negative food indicators.

Socioeconomic and Demographic Data:

Socioeconomic and demographic data used in this analysis were based on the 2000 census conducted by the United States Census Bureau, and provided by the Community Geographer's Office at Syracuse University (Appendix 1). 2000 census tract level data was chosen for this analysis because of the removal of SF3 data from the 2010 census, high margins of error found in the 2011 5-year American Community Survey

which now serves as a replacement for SF3 data, and relatively stable socioeconomic and demographic profile of the region [Jonnell Robinson, Syracuse University Community Geographer, personal communication].

Community Data:

In addition to census information, the Syracuse Hunger Project and the Community Geographer's Office at Syracuse University provided the spatial locations of emergency food assistance programs such as food pantries, soup kitchens, and senior dining centers; the locations of farmers markets within Syracuse; and the geospatial delineation of Syracuse neighborhoods (Appendix 1).

Measuring Physical Accessibility to Markets:

To determine the physical accessibility, I employed the three measures of accessibility utilized by Apparicio et al. illustrating the proximity to the closest grocer, diversity of grocers within 1km, and variety of grocers based on the average distance to the three nearest grocers, using accessibility models I created in ArcMap 10 (Appendices 3, 4, 5, 6) [22]. These models were used to map: i) the spatial distribution of high quality grocers and physical accessibility to grocers at the *census tract level*, ii) the spatial distribution of high and intermediate quality grocers and physical accessibility to grocers at the *census tract level*, iii) the spatial distribution of high quality grocers and physical accessibility to grocers at the *neighborhood level*, and iv) the spatial distribution of high and intermediate quality grocers and physical accessibility to grocers at the *neighborhood level*. Physical accessibility maps were then compared to one another to determine

similarities and differences in measuring accessibility on the census tract level versus the neighborhood level, and in measuring accessibility to high quality grocers versus high quality grocers with the addition of intermediate quality grocers. Although accessibility measures utilized in previous geographic information system studies employ the use of street network analysis [6, 22], euclidean distance-based measures have been shown to generate the same relative patterns of food access and served as the basis for this analysis [28].

Measuring Social Deprivation:

I used 2000 Census data to create a social deprivation index (SDI) at the tract level. The SDI identifies communities with a heightened risk of food insecurity based on six socioeconomic and demographic factors that include: i) the percentage of families below the poverty level, ii) the percentage of unemployed individuals, iii) the percentage of households without access to a vehicle, iv) the percentage of female-headed households with no husband present and children under the age of 18, v) the percentage of minority individuals, and vi) the percentage of adults over the age of 25 with less than a high school education [6, 22] (Table 1). This SDI represents the sum of these variables collected at the census tract level and standardized on a 0 to 1 scale. The final SDI values vary from 0 (minimum deprivation) to 6 (maximum deprivation).

Table 1: Descriptive Statistics of Social Deprivation Index Variables in Census Tracts in Syracuse, NY						
	Families Below Poverty Level (%)	Unemployed (%)	No Vehicle Access (%)	Female Head of Household, No Husband Present, Children Under 18yrs (%)	Minority Status (%)	Adults with less than a High School Education (%)
Mean	22.36	10.07	27.43	13.74	36.12	25.07
Std Deviation	14.64	6.45	16.53	9.01	25.82	13.27
Minimum	0.00	1.74	4.55	1.33	2.87	1.00
Maximum	52.40	28.97	66.35	39.79	90.98	56.50
Percentiles						
5%	1.00	2.60	5.84	2.78	6.22	4.64
10%	2.64	3.31	7.66	4.24	7.21	6.96
25% Q1	8.10	4.86	11.63	5.59	15.22	15.50
50% Median	22.90	8.96	28.08	12.63	27.22	25.30
75% Q3	33.80	12.94	39.75	17.01	62.64	35.10
90%	41.52	20.67	52.23	28.33	78.32	42.36
95%	48.68	23.33	56.89	30.73	88.27	47.50

Mapping Accessibility and Social Risk to Identify Communities of Concern:

I constructed a boolean “and” overlay at the census tract level to rank tracts based on their level of food security risk (See spatial model, Appendix 7). This overlay utilized seven map layers. The first six layers were generated using the three measures of physical accessibility at the census tract level (proximity, diversity, and variety), each measure was employed twice – once for high quality grocers alone, and secondly for high and intermediate quality grocers collectively (Appendices 3, 4). These six layers were converted to rasters and reclassified (Appendix 7). Tracts with a distance greater than 1km to the closest grocer from the tract centroid were given a value of 1, and tracts with a distance of less than 1km were given a value of 0 (proximity). Tracts with one or more grocers within 1km of the tract centroid were given a value of 0, and those with no

grocers within 1km were given a value of 1 (diversity). Tracts with a greater than average mean distance to three different grocers from the tract centroid were given a value of 1, and tracts with a lower than average mean distance were given a value of 0 (variety).

The seventh layer was generated based on SDI values calculated at the census tract level (Table 1). This final layer was converted to a raster and reclassified such that a value of 0-1=0; 1-2=1; 2-3=2... (Appendix 7). Although the seven boolean “and” overlay map layers utilized to identify the communities of greatest concern incorporate some repetitive data, this allows for greater weight to be given to areas that meet multiple physical and social risk indicators, and provides a more comprehensive understanding of the areas within Syracuse that exhibit the highest risk of food insecurity. Through adding each of the seven layers and computing a tract score ranging from 0 to 12, I was able to identify census tracts with the highest score, indicating areas of the greatest risk.

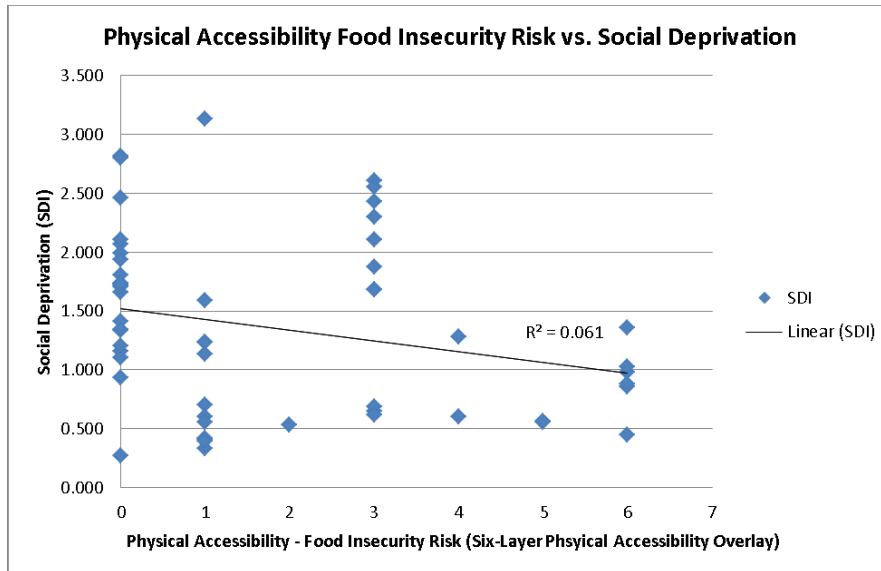
Risk values were also calculated from the first six-layers used in the boolean “and” overlay, generating values ranging from 0-6, illustrating physical accessibility food insecurity risk. These physical accessibility values were graphed against SDI values, each evaluated at the census tract level, to test my hypothesis: areas with the greatest social deprivation will also exhibit reduced physical accessibility. To ensure this method of risk calculation was not biased and further evaluate my hypothesis, the distance to the closest high quality grocer from the tract centroid was also graphed against SDI values, each evaluated at the census tract level. Linear trendlines and R^2 values were calculated and added to each graph to determine correlation.

Mapping Food Supplier Density:

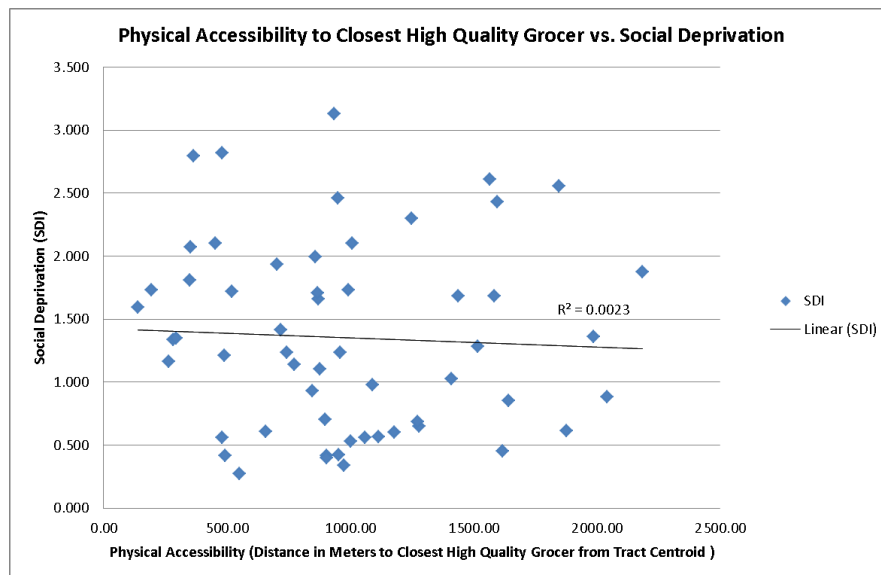
Food supplier densities at both the census tract level and neighborhood level were determined based on the presence of soup kitchens, food pantries, senior dining sites, farmers markets, high quality grocers, intermediate quality grocers, and low quality grocers within the boundaries of their respective census tract or neighborhood. These food supplier point files were spatially joined to the source layer (tract or neighborhood), and summary statistics were used to tally the total number of each type of food supplier within the source layer boundary (See spatial models, Appendices 8, 9).

VII. Results

My hypothesis was not supported, and no correlation was observed between social deprivation and physical accessibility within my analysis. The scatterplot graph of physical accessibility food insecurity risk (generated from the six-layer physical accessibility overlay) versus social deprivation index values illustrated virtually no correlation, with an R^2 value of 0.061 (Graph 1). The scatterplot graph of physical accessibility based on the distance to the closest high quality grocer from the tract centroid versus social deprivation also illustrated no correlation, with an R^2 value of 0.0023 (Graph 2). In spite of this, there are strong spatial patterns of food insecurity and social deprivation at both the census tract and neighborhood levels.



Graph 1 – Physical Accessibility Food Insecurity Risk vs. Social Deprivation



Graph 2 – Physical Accessibility to Closest High Quality Grocer vs. Social Deprivation

Measuring Physical Accessibility to Markets:

Census Tract Level Analysis

Nearly 61% of census tracts have access to at least one high quality grocer within 1km of the tract centroid and 25% of census tracts have access to two high quality grocers (Figure 1). The average distances to the three closest high quality grocers from the tract centroid range in value from 772m to 2,684m with a mean value of 1,484m.

When intermediate quality grocers are joined with high quality grocers, nearly 86% of census tracts have access to at least one grocer within 1km of the tract centroid and 45% of census tracts have access to two or more high or intermediate quality grocers (Figure 2). The maximum number of high or intermediate quality grocers considered accessible to any single tract is 12, with a mean value of 3.36 grocers. The census tracts with the greatest high and intermediate quality grocer accessibility, between 9 and 12 grocers per tract, are clustered in the northside of the city (Figure 2). The average distances to the three closest high and intermediate quality grocers from the tract centroid range in value from 282m to 1,658m with a mean value of 868m. High quality grocers appear to be largely absent from the southwest side of the city, although this area also has a higher quantity of intermediate quality grocers (Figure 2). In addition, the census tracts located around the perimeter of the city appear to have fewer high and intermediate quality grocers; however, many high quality grocers are located just outside of the city boundary (Figure 2).

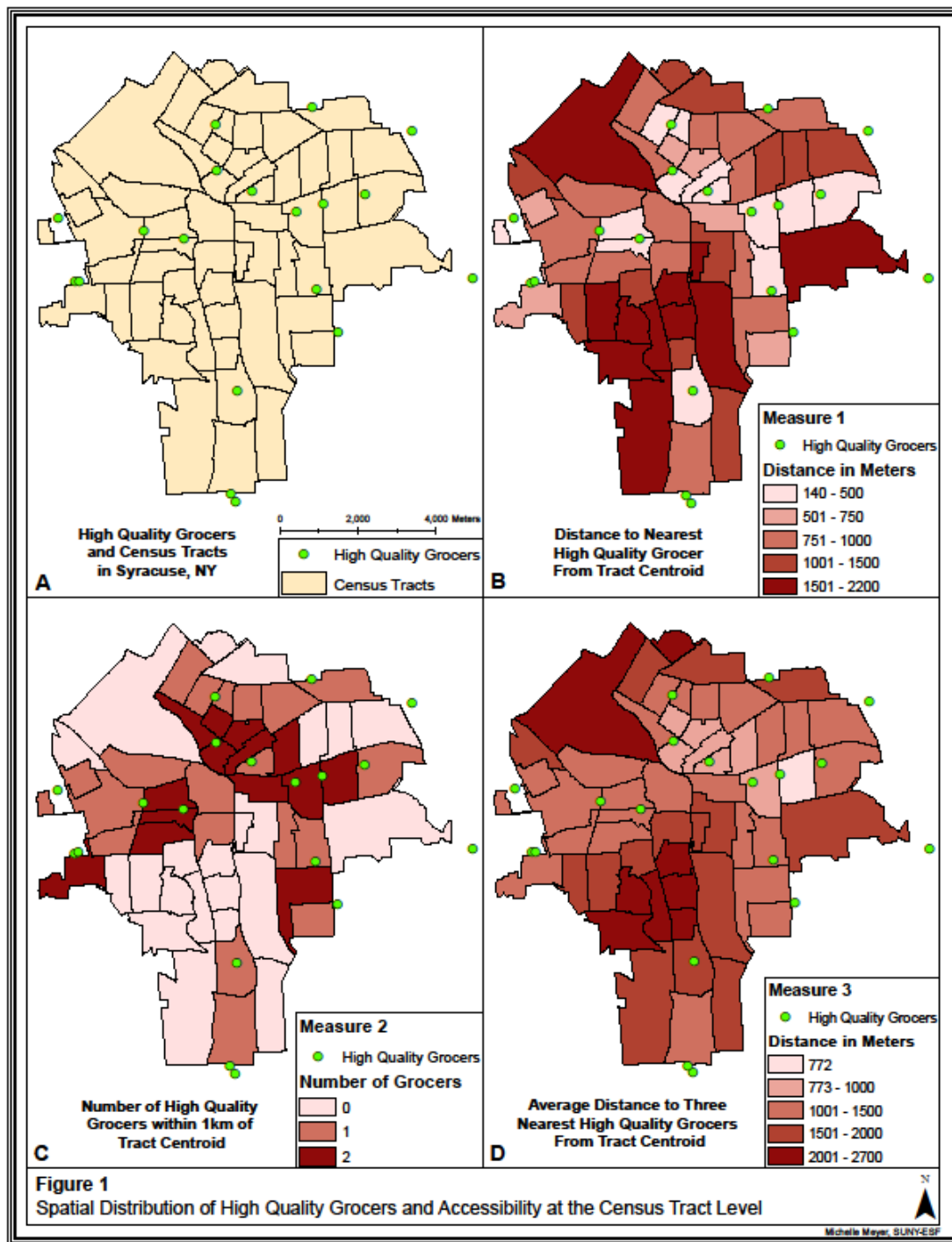


Figure 1 – Spatial Distribution of High Quality Grocers and Physical Accessibility at the Census Tract Level

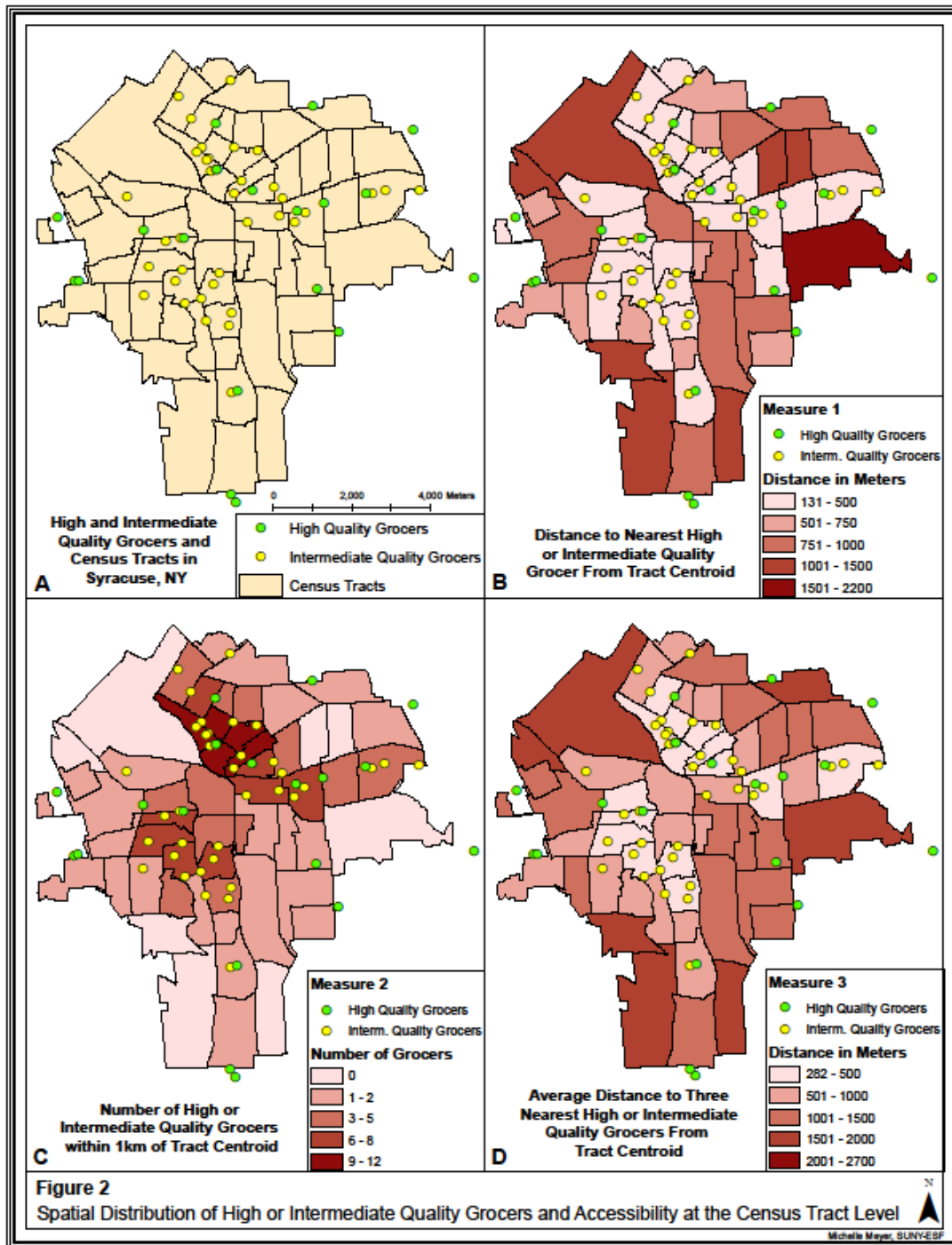


Figure 2 – Spatial Distribution of High and Intermediate Quality Grocers and Physical Accessibility at the Census Tract Level

Neighborhood Level Analysis

Nearly 63% of neighborhoods have access to at least one high quality grocer within 1km of the neighborhood centroid and 22% of neighborhoods have access to two high quality grocers (Figure 3). Neighborhoods with no access to a high quality grocer include Lakefront, Court-Woodlawn, Sedgwick, Eastwood, Meadowbrook, University Hill, Southside, Strathmore, Elmwood, Brighton, Outer Comstock, and the South Valley. The Winkworth, Near Westside, Prospect Hill, Hawley-Green, Near Eastside, Lincoln Hill, and Northside neighborhoods all have access to two high quality grocers (Figure 3). The average distances to the three nearest high quality grocers from the neighborhood centroid range in value from 686m to 2,552m with a mean value of 1,479m. More than half (56%) of neighborhoods have an average distance to the three nearest high quality grocers less than the mean, and the greatest average distances (greater than 2000m) are observed in the Elmwood, Brighton, Southside, and Lakefront neighborhoods (Figure 3).

When intermediate quality grocers are joined with high quality grocers, nearly 84% of neighborhoods have access to at least one grocer within 1km of the tract centroid and 41% of neighborhoods have access to two or more high or intermediate quality grocers (Figure 4). Neighborhoods with no access to a high or intermediate quality grocer include Lakefront, Elmwood, South Valley, Meadowbrook, and Eastwood (Figure 4). The maximum number of high or intermediate quality grocers considered accessible to any single neighborhood is 12, with a mean value of 3.53 grocers. The Northside, Prospect Hill, and Southwest neighborhoods all have the greatest grocer accessibility, with between 9 and 12 high or intermediate grocers per neighborhood (Figure 4). The

average distances to the three nearest high and intermediate quality grocers from the neighborhood centroid range in value from 184m to 1,604m with a mean value of 875m.

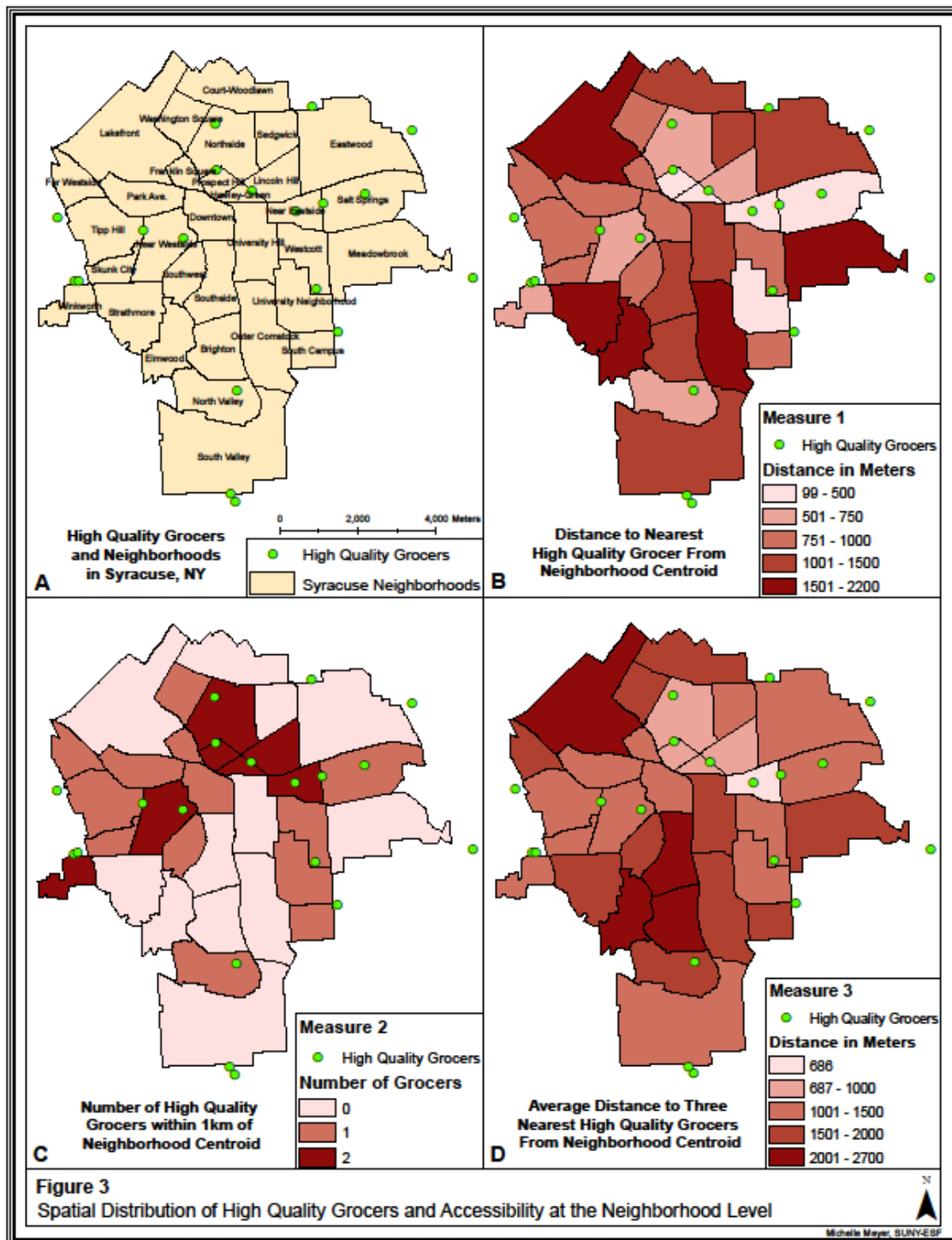


Figure 3 – Spatial Distribution of High Quality Grocers and Physical Accessibility at the Neighborhood Level

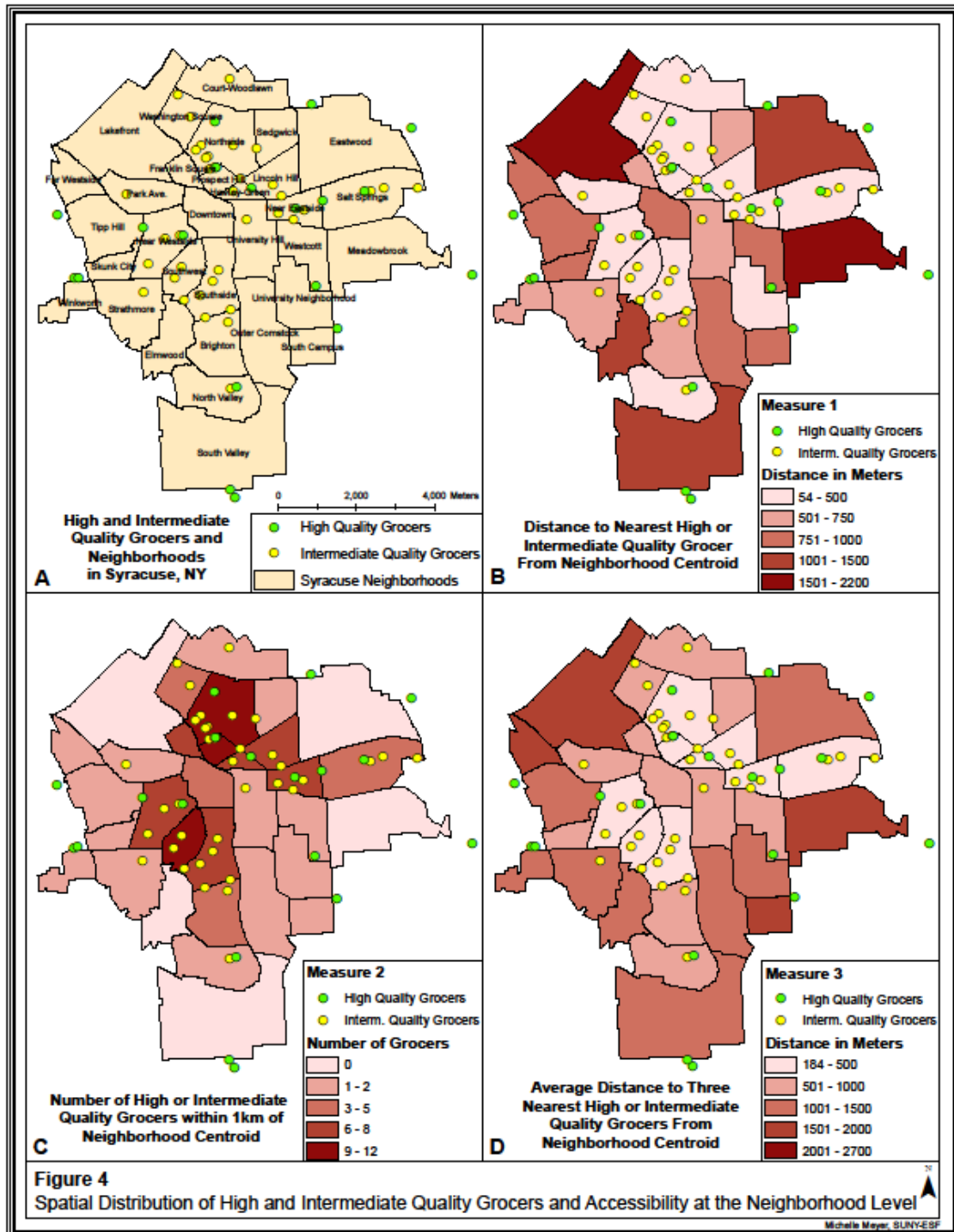


Figure 4 – Spatial Distribution of High and Intermediate Quality Grocers and Physical Accessibility at the Neighborhood Level

Measuring Social Risk:

Calculated SDI values ranged from 0 to 3.13, with a mean value of 1.33. Nearly 14% of census tracts exhibit the highest levels of social deprivation, with SDI values ranging from 2.11 to 3.13. These census tracts are clustered within the southwest and southside areas of the city (Figure 5). Roughly 13% of census tracts exhibit the lowest levels of social deprivation, with SDI values ranging from 0.00 to 0.45. These census tracts are largely located around the perimeter of the city (Figure 5). 52% of census tracts have a SDI value greater than the average, and all of these tracts are clustered in the interior of the city.

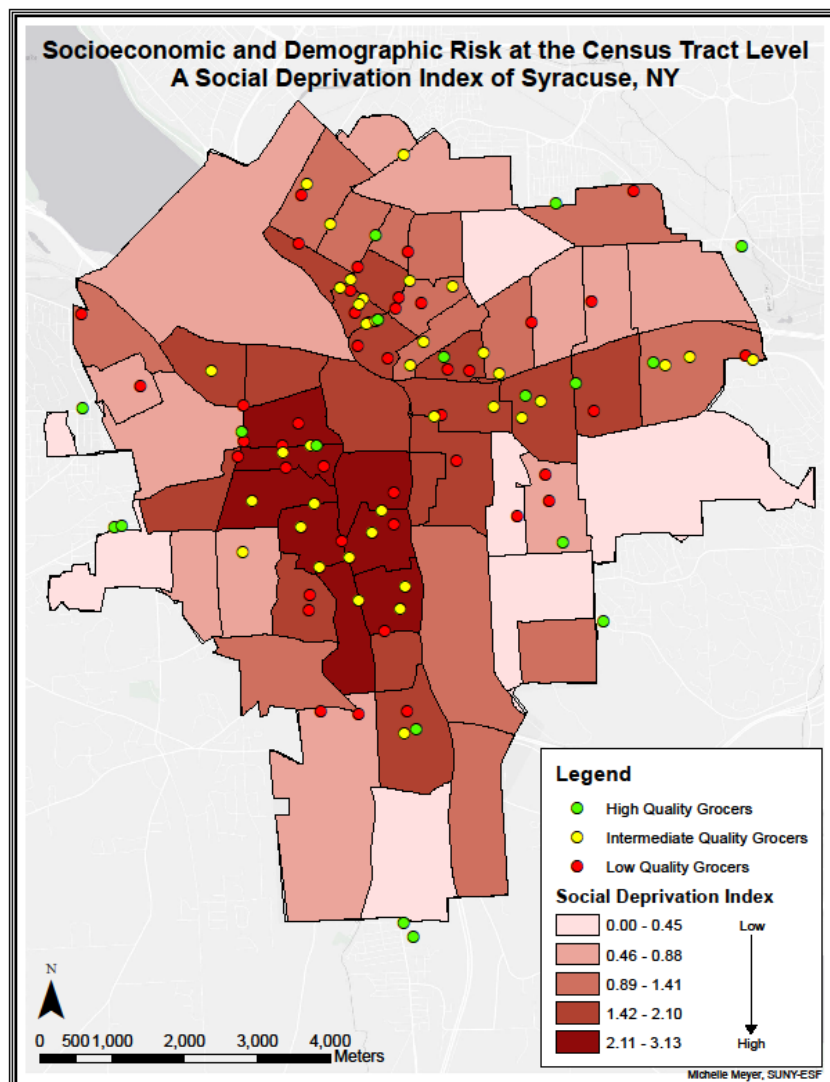


Figure 5 – Socioeconomic and Demographic Risk at the Census Tract Level

Mapping Accessibility and Social Risk to Identify Communities of Concern:

Approximately 9% of census tracts exhibit very high risk of food insecurity (Risk of 7-8). These tracts are located in the northwest and southern parts of the city (Figure 6). Roughly 4% of census tracts exhibit no risk of food insecurity (Risk of 0), and 57% of census tracts exhibit a low risk of food insecurity (Risk of 1-2). 14% of census tracts exhibit an intermediate risk of food insecurity (Risk 3-4), and 16% of census tracts exhibit a high risk of food insecurity (Risk 5-6). In total, 25% of census tracts exhibit high or very high risk of food insecurity and can be considered communities of concern. These tracts are predominantly clustered in the southern portion of the city, although additional communities of concern can also be found in the northwest and eastern portions of the city (Figure 6).

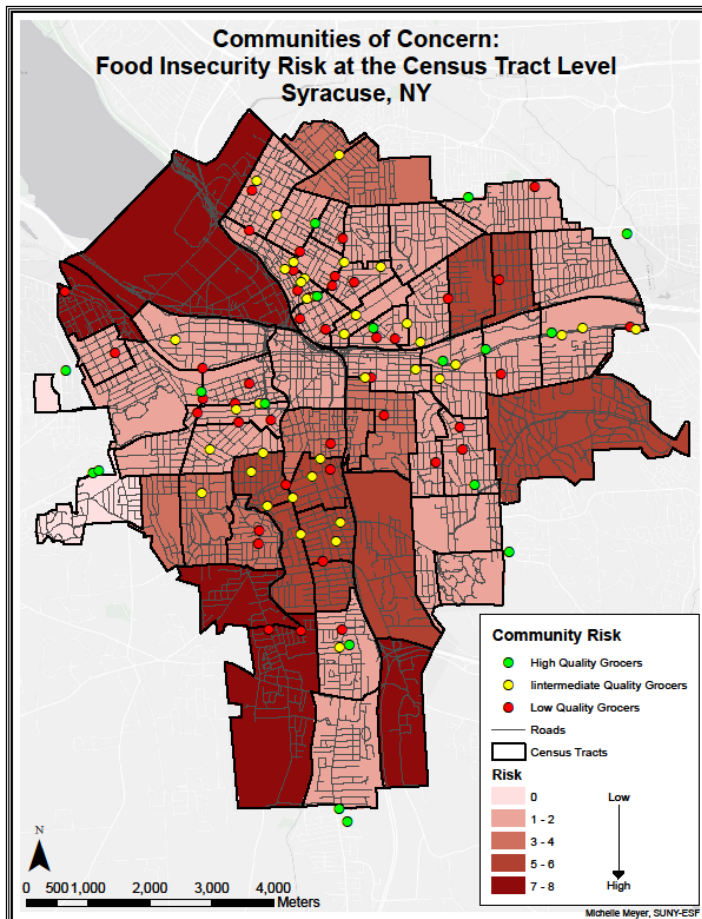


Figure 6 – Communities of Concern: Food Insecurity Risk at the Census Tract Level

Mapping Food Supplier Density:

Census Tract Level Analysis

Through analyzing food supplier density, one is able to gain a clearer picture of the local food environment within each tract area, including relative quality and diversity of grocer types available to residents. Low quality grocers and emergency food assistance largely dominate census tracts within the southern portion of Syracuse (Figure 7). Similar patterns of dominance by low quality markets can be observed in parts of the northside, although the northside also has a greater prevalence of intermediate quality grocers (Figure 7). The census tracts within the interior of the city appear to have a greater density of emergency food assistance programs than those around the perimeter of the

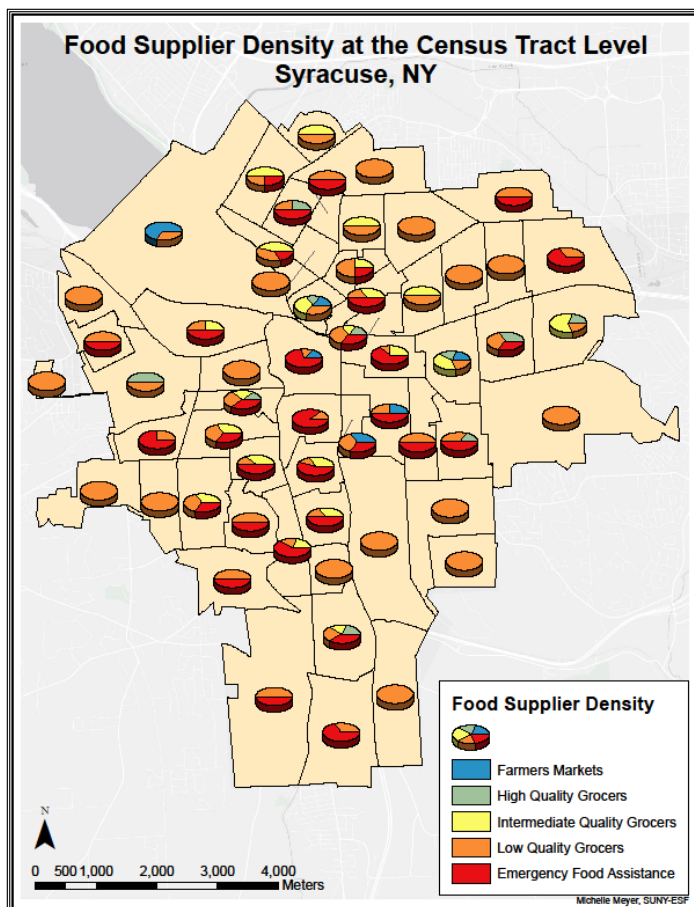
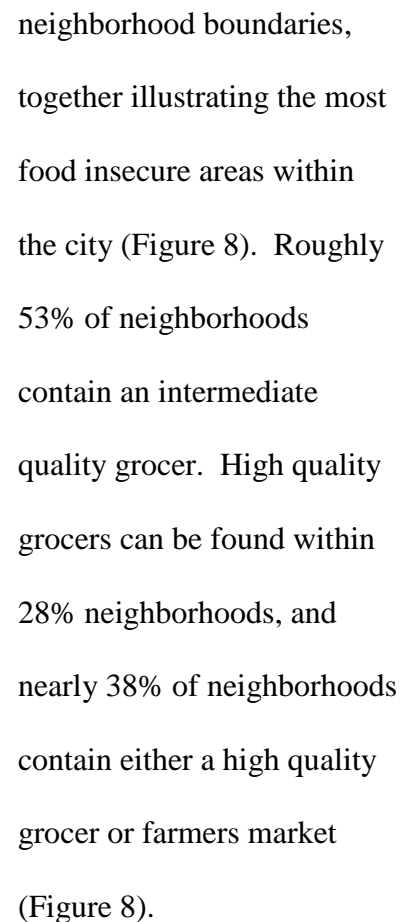


Figure 7 – Food Supplier Density at the Census Tract Level

city (Figure 7). 29% of census tracts contain only low quality grocers within their tract boundaries, and 48% of census tracts contain only low quality grocers or emergency food assistance programs within their tract boundaries. Although 61% of census tracts have a high quality grocer within 1km of the tract centroid, approximately 18% of census tracts actually contain a high quality grocer.

Roughly 16% of neighborhoods including the Franklin Square, Meadowbrook, South Campus, Outer Combstock, and Winkworth have no food suppliers of any type located within neighborhood boundaries, represented by a lack of any pie chart (Figure 8). The South Valley neighborhood has only emergency food assistance programs located within the neighborhood boundary, and 16% of neighborhoods including the University Neighborhood, Eastwood, Far Westside, Skunk City, and Elmwood contain only low quality grocers and emergency food assistance programs within their



31

VIII. Discussion

The cluster of census tracts in the southern portion of the city that exhibit a high or very high risk of food insecurity (Risk of 5-8) also exhibit high SDI values, yet no correlation was found across the city between these two factors (Graph 1; Figures 5, 6). This cluster of census tracts also contain a greater density of emergency food programs, low quality grocers and intermediate quality grocers, and fewer high quality grocers; indicating these areas may represent the most food insecure regions of the city (Figures 7, 8). Although the very high risk Lakefront area in the northwestern portion of the city has access to a farmers market, farmers markets were not considered within the larger identification of communities of concern due to limited hours of operation (Figures 6, 7, 8).

A portion of the high and very high risk communities of concern (Risk of 5-8; including both physical accessibility and SDI) also exhibit a relatively low SDI when compared to the rest of the city, particularly in the Meadowbrook neighborhood, and may in turn experience greater mobility in accessing more distant markets (Figures 5, 6). Although physical and social accessibility were weighted equally in the seven layer boolean “and” overlay, the computed range of SDI values (0-3.13, rather than 0-6) may have resulted in physical accessibility factoring more predominantly in the final identification of communities of concern. Communities of concern identified in Figure 6 are also not representative of traditional “food deserts” defined by limited physical *and* economic access, as some of these areas do not meet social deprivation thresholds. However, identifying communities of concern in this manner may prove more helpful for individuals within higher-income neighborhoods who suffer from additional barriers to

access not characteristic to their surrounding area, such as the elderly with potential restrictions in mobility. It is possible a geospatial overlay of physical and societal factors may prove more useful in identifying communities of concern through the inclusion of food hinterlands in addition to traditional food deserts; however, this is an area where a significant amount of additional research is necessary.

These findings somewhat reciprocate other studies on food security in that certain areas exhibiting social deprivation also exhibited reduced physical access; however, my findings differ in that no correlation was observed between social deprivation and physical accessibility to quality grocers within the city as a whole (Figures 5, 6, 7, 8) [6, 7, 8, 9]. This is likely due to the opening of new chain-grocers in areas of heightened social risk, such as the new Tops Friendly Markets recently opened in the valley neighborhood; the prevalence of intermediate quality grocers throughout the city; the absence of quality grocers in areas with relatively low social deprivation; and importance of other market dynamics. The flight of high quality grocers from urban areas is often encouraged by the relative purchasing power of suburban markets in comparison to urban markets, and economies of scale available to large suburban-based retailers [11, 12, 13, 14]. In addition, the form of a city tends to be antithetical to supermarkets, as transportation is facilitated by the interstate system and more easily accomplished in suburban areas than within denser urban centers, which also lack ample land and space for parking [13, 14]. The modern economic model of large grocers also requires suppliers to keep shelves fully stocked due to little on-site storage, highlighting the importance of improved transportation and trucking access for cheaper sourcing of commodity food items [13, 14]. Although there are many high quality grocers located

around the perimeter of the city (Figure 6), the recent opening of new large-chain grocers within city boundaries (Tops Friendly Markets and PriceRite) challenges the tendency of larger grocers to flee urban areas to better meet the needs of a more economically privileged suburban clientele. However, the recent closing of Wegmans in Syracuse's northside and success of Wegmans Dewitt, located just outside of the city, also suggests this phenomenon may in part continue.

When comparing the physical accessibility to high quality grocers alone or with the addition of intermediate quality grocers, both on the census tract and neighborhood level, the impact of intermediate quality grocers on the food landscape becomes clear. In each case, the addition of intermediate quality grocers to the analysis greatly increased the percentage of census tracts and neighborhoods with at least one grocer within 1km of the centroid (61% to 68%, and 63% to 84% respectively). In addition, the inclusion of intermediate quality grocers increased the maximum number of accessible markets from any one centroid from 2 grocers to 12 grocers on both the tract and neighborhood level (Figures 1-4). The addition of intermediate quality grocers also dramatically reduced the average distance to the three nearest markets, resulting in the reduction of the mean distance for all census tracts by 41.5% and 40.8% for neighborhoods. Furthermore, the minimum average distance was reduced from 772m to 282m in the tract level analysis, and from 686m to 184m in the neighborhood level analysis. The maximum distance was also reduced from 2684m to 1658m on the tract level, and from 2552m to 1604m on the neighborhood level. These findings suggest the importance of intermediate quality grocers in improving physical accessibility within Syracuse, while also highlighting the enhanced role such grocers play in enhancing food security.

In addition, while a tract level analysis is beneficial when considering social deprivation through the use of socioeconomic and demographic census data attributes, residents may not necessarily identify with their corresponding census tract. In turn, residents may be more likely to identify with their respective neighborhoods, making a neighborhood level analysis more useful for outreach efforts.

Although there was no correlation observed between social deprivation and physical accessibility to quality grocers, socially deprived areas with limited physical access may experience greater risks of negative individual and public health outcomes as a result of enhanced accessibility constraints [4, 6, 10, 15, 16, 17], and should serve as the focus for future research and efforts to improve food security. However, a study by Hiller et al. in 2011 demonstrated many WIC recipients rarely shop at the supermarket closest to their household, indicating access may not be synonymous with geographic proximity to grocers [29]. Future research within the indicated communities of concern could provide insight as to where residents do the majority of their shopping, and if physical access is indeed a barrier to purchasing healthful foods. Bader et al. also suggest physical distance is not necessarily indicative of travel burden, or the time cost and difficulty of moving between two points, and found additional factors such as vehicle ownership, mobility impairments due to poor health or disability, infrequent bus service, unsafe traffic conditions and crime “hot spots” to influence travel burden [6].

IX. Conclusion

Food accessibility within urban environments is influenced by a wide variety of factors including physical distance, socioeconomic status, infrastructure and transportation routes, regional climate, industrialization, and other political-economic

dynamics. Although there are many challenges facing regional food justice and improved accessibility for city residents, identifying communities of concern and geospatially mapping the food landscape and the geography of hunger enables us to identify areas with the most food assistance need. In addition, understanding the geography of hunger can help food justice advocates promote equitable access to nutritious food-stuff for all city residents, in turn promote beneficial health outcomes and improving the quality of life throughout the city as a whole.

One potential method to address gaps in food availability and accessibility unique to Syracuse involves the use of urban agriculture as a capacity building strategy for the revitalization of vacant lands throughout the city. Urban agriculture, including community gardening activities, has the potential to create a more sustainable urban ecological system, improve food security and the health of local residents, improve the local economy and employment opportunities, and promote community cohesion – a strategy currently under investigation by the Atlantic States Legal Foundation. However, increasing the scope and scale of urban agriculture also faces challenges such as funding, the expense of labor and economic viability of operations, public perception, local land claims and zoning policies, and environmental factors such as site contamination and seasonality. Further, a biophysical assessment of Syracuse published in 2011 found the area of impervious surfaces to be substantially higher in less affluent neighborhoods, illustrating potential difficulties in food production within areas with the greatest need [20]. Future studies may seek to quantify the amount of food that can be grown in these vacant spaces given exposure to sunlight, environmental toxins and remediation needs, water demands, and other environmental criteria, as well as the economic impact of UA.

Although the city of Syracuse faces many challenges in terms of food access and availability for city residents, the persistent need for redevelopment presents a unique opportunity for city planners to improve the overall economic vitality and function of the city. A considerable amount of research is needed to fully quantify the economic impacts of a renewed urban agricultural economy; however, increased attention to such concerns, and improved communication between city-planners, designers, and municipal leaders has the potential to dramatically improve the local agro-food system, revitalize the local economy, and provide equitable food accessibility and health opportunities to all city residents.

X. References

1. Economic Research Service (ERS), United States Department of Agriculture (USDA). USDA, 4 Sept. 2012. Web. 14 Sept. 2012.
2. Leete, Laura, Neil Bania, and Andrea Sparks-Ibanga. "Congruence and Coverage: Alternative Approaches to Identifying Urban Food Deserts and Food Hinterlands." *Journal of Planning Education and Research* 32.2 (2012): 204-218.
3. Weissman, Evan. "Hunger (& Obesity)." HTW 400 Feeding the City, Syracuse University, Hall of Languages, Syracuse, NY. 26 Feb. 2013. Lecture.
4. Brown, Katherine. "Urban Agriculture and Community Food Security in the United States: Farming from the City Center to the Urban Fringe." Urban Agriculture Committee of the Community Food Security Coalition, Feb. 2002. Web. 18 May 2011. PDF File.
5. Johnson, Dale, Don Mitchell, and Jane Read. "Syracuse Hunger Project Executive Report: Presentation to the Community." Syracuse Hunger Project, 23 Apr. 2004. Web. 7 Sept. 2012. PDF File.
6. Bader, Michael D. M., Marnie Purciel, Paulette Yousefzadeh, and Kathryn M. Neckerman. "Disparities in Neighborhood Food Environments: Implications of Measurement Strategies." *Economic Geography* 86.4 (2010): 409-430.
7. Chung, Chanjin, and Samuel L. Myers, Jr. "Do the Poor Pay More for Food? An Analysis of Grocery Store Availability and Food Price Disparities." *The Journal of Consumer Affairs* 33.2 (1999): 276-296.
8. Kaufman, Phillip R., James M. MacDonald, Steve M. Lutz, and David M. Smallwood. "Do the Poor Pay More for Food? Item Selection and Price Differences Affect Low-Income Household Food Costs." United States Department of Agriculture, Economic Research Service, November 1997. Web. 18 Oct. 2012.
9. Yamashita, Takashi, and Suzanne R. Kunkel. "Geographic Access to Healthy and Unhealthy Foods for the Older Population in a U.S. Metropolitan Area." *Journal of Applied Gerontology* 31.3 (2012): 287-313.
10. Algert, Susan J., Aditya Agrawal, and Douglas S. Lewis. "Disparities in Access to Fresh Produce in Low-Income Neighborhoods in Los Angeles." *American Journal of Preventative Medicine* 30.5 (2006): 365-370.
11. Alwitt, Linda F., and Thomas D. Donley. "Retail Stores in Poor Urban Neighborhoods." *Journal of Consumer Affairs* 31 (1997): 139-370.
12. Andreyeva, Tatiana, Daniel M. Blumenthal, Marlene B. Schwartz, Michael W. Long, and Kelly D. Brownell. "Availability and Prices of Foods Across Stores and Neighborhoods: The Case of New Haven, Connecticut." *Health Affairs* 27.5 (2008): 1381-1388.
13. Steel, Carolyn. *Hungry City: How Food Shapes our Lives*. London: Chatto & Windus, 2008.
14. Winne, Mark. *Closing the Food Gap: Resetting the Table in the Land of Plenty*. Boston: Beacon Press, 2008.
15. Moreland, Kimberly, Steve Wing, and Ana Diez Roux. "The Contextual Effect of the Local Food Environment on Residents' Diets: The Atherosclerosis Risk in Communities Study." *American Journal of Public Health* 92.11 (2002): 1761-1767.

16. Moore, Latetia V., Ana V. Diez Roux, Jennifer A. Nettleton, and David R. Jacobs Jr. "Associations of the Local Food Environment with Diet Quality – A comparison of Assessments Based on Surveys and Geographic Information Systems." *American Journal of Epidemiology* 167.8 (2008): 917-924.
17. Powell, Lisa M., M. Christopher Auld, Frank J. Chaloupka, Patrick M. O'Malley, and Lloyd D. Johnston. "Associations Between Access to Food Stores and Adolescent Body Mass Index." *American Journal of Preventative Medicine* 33.4S (2007): S301-S307.
18. Pendall, Rolf. "Sprawl Without Growth: The Upstate Paradox." *The Brookings Institution*, The Brookings Institution Center on Urban and Metropolitan Policy, Oct. 2003. Web. 5 May 2013.
19. Johnson, David L., and Jennifer K. Bretsch. "Soil Lead and Children's Blood Lead Levels in Syracuse, NY, USA." *Environmental Geochemistry and Health* 24 (2002): 375-385.
20. Hall, Myrna H.P. "A Preliminary Assessment of Socio-ecological Metabolism for Three Neighborhoods within a Rust Belt Urban Ecosystem." *Ecological Modeling* 223 (2011): 20-31.
21. Grengs, Joe. "Does Public Transit Counteract the Segregation of Carless Households? Measuring Spatial Patterns of Accessibility." *Transportation Research Record* 1753 (2001): 3-10.
22. Apparicio, Philippe, Marie-Soleil Cloutier, and Richard Shearmur. "The Case of Montréal's Missing Food Deserts: Evaluation of Accessibility to Food Supermarkets." *International Journal of Health Geographies* 6.4 (2007).
23. United States Census Bureau. "Syracuse (city), New York." *American FactFinder*. U.S. Department of Commerce, United States Census Bureau, 10 Jan. 2013. Web. 8 Feb. 2013.
24. United States Census Bureau. "Profile of Selected Economic Characteristics: 2000 Census 2000 Summary File 3 (SF 3) – Sample Data." *American FactFinder*. U.S. Department of Commerce, United States Census Bureau. Web. 10 Apr. 2013.
25. United States Census Bureau. "Profile of Selected Housing Characteristics: 2000 Census 2000 Summary File 3 (SF 3) – Sample Data." *American FactFinder*. U.S. Department of Commerce, United States Census Bureau. Web. 10 Apr. 2013.
26. United States Census Bureau. "Profile of General Demographic Characteristics: 2000 Census 2000 Summary File 3 (SF 3) – Sample Data." *American FactFinder*. U.S. Department of Commerce, United States Census Bureau. Web. 10 Apr. 2013.
27. Cohen, Barbara, Margaret Andrews, and Linda Scott Kantor. "Community Food Security Assessment Toolkit." Economic Research Service (ERS), United States Department of Agriculture (USDA). USDA, 3 Jun. 2012. Web. 25 Sept. 2012.
28. Sparks, Andrea L., Neil Bania, and Laura Leete. "Comparative Approaches to Measuring Food Access in Urban Areas: The Case of Portland, Oregon." *Urban Studies* 48.8 (2011): 1715-1737.
29. Hiller, Amy, Carolyn C. Cannuscio, Allison Karpyn, Jacqueline McLaughlin, Mariana Chilton, and Karen Glanz. "How Far do Low-Income Parents Travel to Shop for Food? Empirical Evidence from Two Urban Neighborhoods." *Urban Geography* 32.5 (2011): 712-729.

XI. Appendices

Appendix 1: Digital Data Table

Information	Data Model	Projection	Datum	C.S.	Source
NAICS 445110 Supermarket and Other Grocery	.XLS -> Vector (Point)	N/A	NAD83	NAD83	1
NAICS 445120 Convenience Stores	.XLS -> Vector (Point)	N/A	NAD83	NAD83	1
Additional Grocers (i.e. Aldis, Price Chopper, Tops, Wegmans, PriceRite, etc.)	.XLS -> Vector (Point)	N/A	NAD83	NAD83	2
2000 Census Economic Data at the Tract Level	Vector (Polygon)	UTM Zone 18N	NAD83	NAD83	3
2000 Census Employment Data at the Tract Level	Vector (Polygon)	UTM Zone 18N	NAD83	NAD83	3
2000 Census Housing Data at the Tract Level	Vector (Polygon)	UTM Zone 18N	NAD83	NAD83	3
2000 Census Population Data at the Tract Level	Vector (Polygon)	UTM Zone 18N	NAD83	NAD83	3
2000 Census Social Data at the Tract Level	Vector (Polygon)	UTM Zone 18N	NAD83	NAD83	3
2012 Soup Kitchens	Vector (Point)	UTM Zone 18N	NAD83	NAD83	4
2012 Food Pantries	Vector (Point)	UTM Zone 18N	NAD83	NAD83	4
2012 Senior Dining Sites	Vector (Point)	UTM Zone 18N	NAD83	NAD83	4
2012 Farmers Markets	Vector (Point)	UTM Zone 18N	NAD83	NAD83	5
2012 Syracuse Neighborhoods	Vector (Polygon)	UTM Zone 18N	NAD83	NAD83	6
2010 Census Tracts	Vector (Polygon)	N/A	NAD83	NAD83	7
Syracuse Roads	Vector (Line)	N/A	NAD83	NAD83	7

Source:

1. Sm2.simplymap.com
2. Google Earth
3. Community Geographer's Office at Syracuse University – United States Census Bureau 2000 Census
4. Community Geographer's Office at Syracuse University – The Central New York Food Bank
5. Community Geographer's Office at Syracuse University – Farmers Market Federation of New York
6. Community Geographer's Office at Syracuse University – City of Syracuse
7. United States Census Bureau TIGER Products

Appendix 2: Availability and Variety Score Form

Store Number:	Available	Variety*	Notes**	Scoring***
Alcohol for Sale?	(Y / N)			(-1 / 0)
Tobacco for Sale?	(Y / N)			(-1 / 0)
EBT Accepted?	(Y / N)			(1 / 0)
Beans/Legumes	(Y / N)	1 3 5		(0, 1, 3, 5)
Nuts	(Y / N)	1 3 5		(0, 1, 3, 5)
Fresh Fruit	(Y / N)	1 3 5	S P	(0, 1, 3, 5)
Fresh Vegetables	(Y / N)	1 3 5	S P	(0, 1, 3, 5)
Canned Fruit	(Y / N)	1 3 5		(0, 1, 3, 5)
Canned Vegetables	(Y / N)	1 3 5		(0, 1, 3, 5)
Frozen Fruit	(Y / N)	1 3 5		(0, 1, 3, 5)
Frozen Vegetables	(Y / N)	1 3 5		(0, 1, 3, 5)
Breads	(Y / N)	1 3 5		(0, 1, 3, 5)
Cereal	(Y / N)	1 3 5		(0, 1, 3, 5)
Pasta	(Y / N)	1 3 5		(0, 1, 3, 5)
Rice	(Y / N)	1 3 5		(0, 1, 3, 5)
Flour	(Y / N)	1 3 5		(0, 1, 3, 5)
Milk	(Y / N)	1 3 5		(0, 1, 3, 5)
Dairy Products	(Y / N)	1 3 5		(0, 1, 3, 5)
Eggs	(Y / N)	1 3 5		(0, 1, 3, 5)
Fresh Meat Products	(Y / N)	1 3 5		(0, 1, 3, 5)
Frozen Meat Products	(Y / N)	1 3 5		(0, 1, 3, 5)
Fresh Poultry Products	(Y / N)	1 3 5		(0, 1, 3, 5)
Frozen Poultry Products	(Y / N)	1 3 5		(0, 1, 3, 5)
Fresh Fisheries Products	(Y / N)	1 3 5		(0, 1, 3, 5)
Frozen Fisheries Products	(Y / N)	1 3 5		(0, 1, 3, 5)
Sugar	(Y / N)	1 3 5		(0, -1, -3, -5)
Chips	(Y / N)	1 3 5		(0, -1, -3, -5)
Candy	(Y / N)	1 3 5		(0, -1, -3, -5)
Soda/Sugary Drinks	(Y / N)	1 3 5		(0, -1, -3, -5)

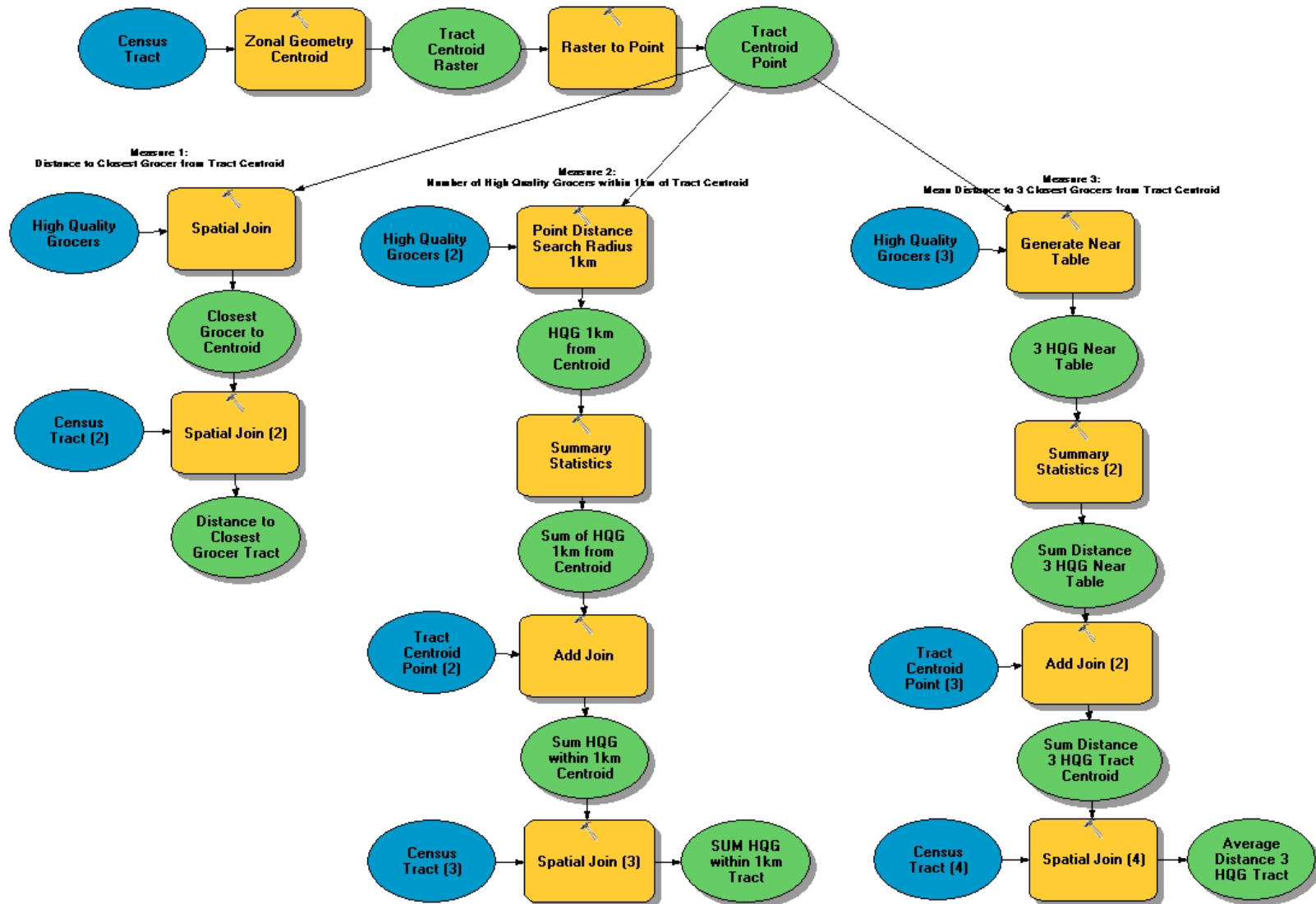
* Variety of 1 indicates availability of 1 or 2 items, variety of 3 indicates availability of 3 or 4 items, and variety of 5 indicates availability of 5 or more items

** S = Satisfactory, P = Poor

*** Scoring was based on availability, a value of 0 being assigned to N, or none, and the subsequent variety of each food category selected (1, 3, or 5) indicating the equivalent value assigned either positively or negatively

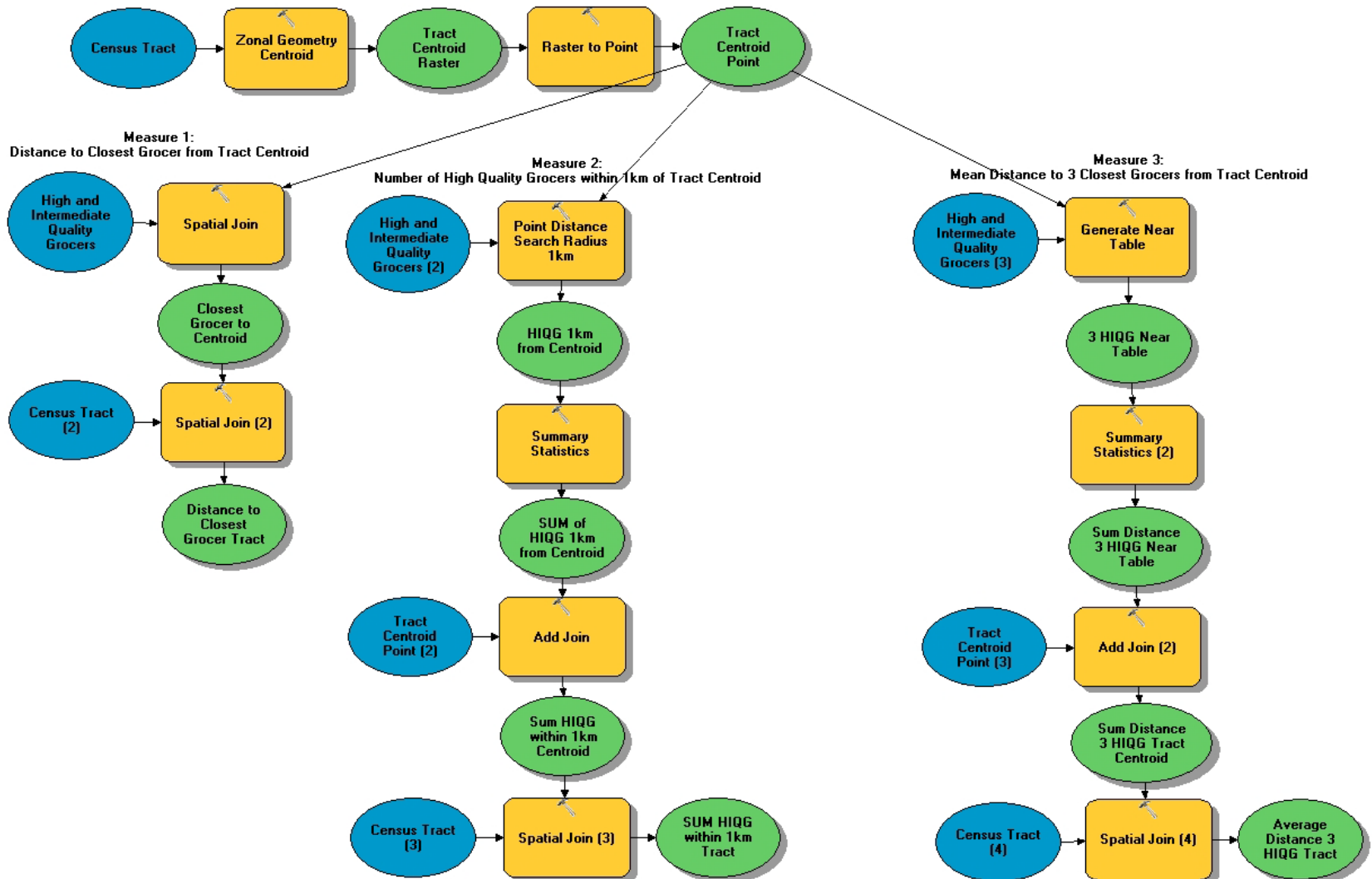
Appendix 3: Model 1 – High Quality Grocery Accessibility at the Tract Level

Model 1: High Quality Grocery Accessibility at the Tract Level



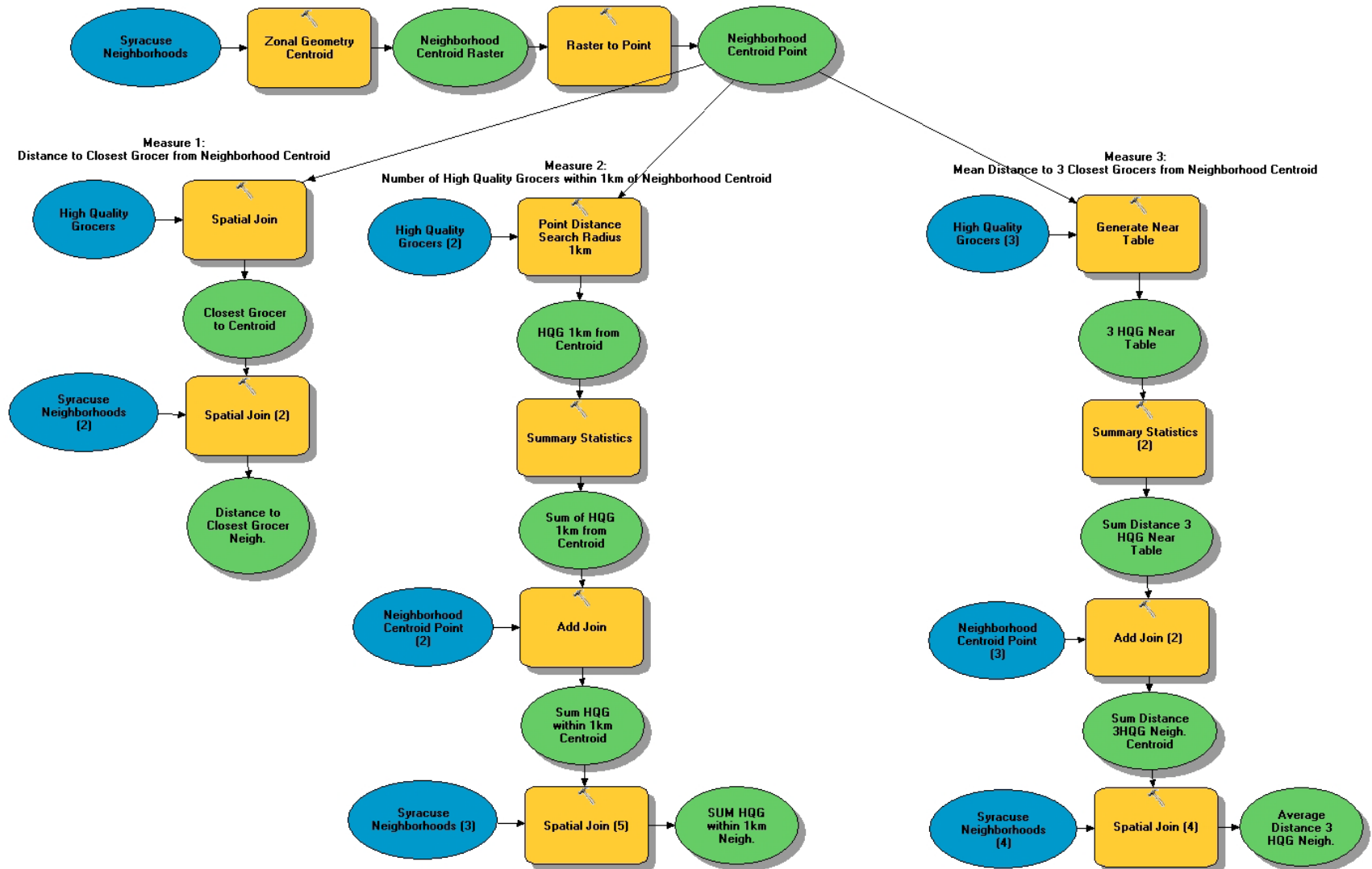
Appendix 4: Model 2 – High and Intermediate Quality Grocery Accessibility at the Tract Level

Model 2: High and Intermediate Quality Grocery Accessibility at the Tract Level



Appendix 5: Model 3 – High Quality Grocery Accessibility at the Neighborhood Level

Model 3: High Quality Grocery Accessibility at the Neighborhood Level



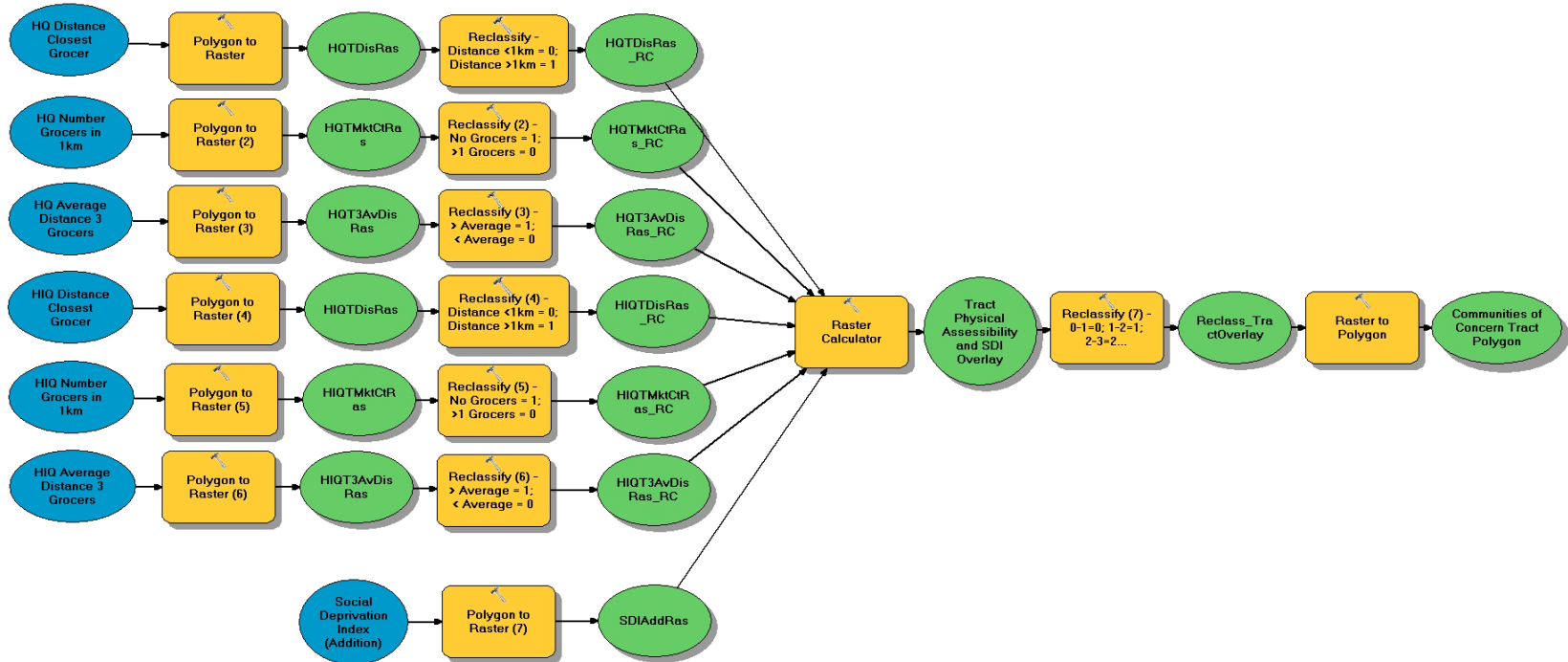
Appendix 6: Model 4 – High and Intermediate Quality Grocery Accessibility at the Neighborhood Level

Model 4: High and Intermediate Quality Grocery Accessibility at the Neighborhood Level



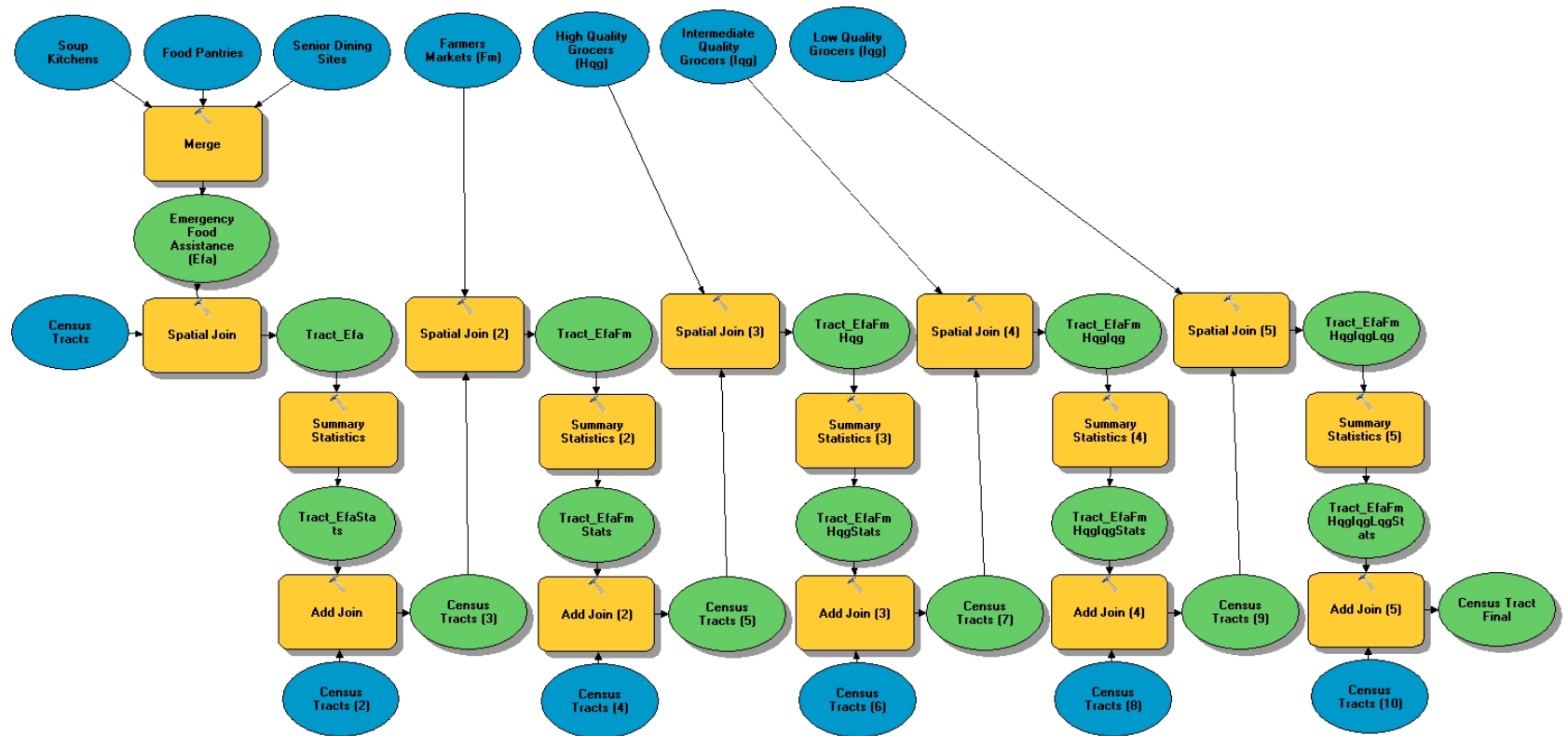
Appendix 7: Model 5 – Identifying Communities of Concern

Model 5: Identifying Communities of Concern



Appendix 8: Model 6 – Food Supplier Density at the Census Tract Level

Model 6: Food Supplier Density at the Census Tract Level



Appendix 9: Model 7 – Food Supplier Density at the Neighborhood Level

Model 7: Food Supplier Density at the Neighborhood Level

